410 Rec'd PCT/PTO 10 SEP 2001

EXPRESS MAIL LABEL NO. EL653252170US

FORM PTO-1390 (REV 10-2000) U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE	ATTORNEY'S DOCKET NUMBER
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371	FRR-12655
	U.S. APPLICATION NO. (If known, see 37 CFR 1.5) 09/936277

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/CH00/00040	28 January 2000	11 March 1999

TITLE OF INVENTION
ACTIVE ELECTRO-OPTIC FILTERING DEVICE AND METHOD FOR OPERATING SAME

APPLICANT(S) FOR DO/EO/US
KELLER, Leo; ACKERMANN, Emil

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. [X] This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. [ ] This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. [ ] This is an express request to promptly begin national examination procedures (35 U.S.C. 371(f)).
4. [X] The US has been elected by the expiration of 19 months from the priority date (PCT Article 31).
5. [X] A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. [ ] is attached hereto (required only if not communicated by the International Bureau).
   b. [X] has been communicated by the International Bureau.
   c. [ ] is not required, as the application was filed in the United States Receiving Office (RO/US).
6. [X] An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
7. [X] Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. [ ] are attached hereto (required only if not communicated by the International Bureau).
   b. [ ] have been communicated by the International Bureau.
   c. [ ] have not been made; however, the time limit for making such amendments has NOT expired.
   d. [X] have not been made and will not be made.
8. [ ] An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. [X] An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. [X] An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11 to 16 below concern document(s) or information included:

11. [X] An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. [ ] An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. [X] A FIRST preliminary amendment.
    [ ] A SECOND or SUBSEQUENT preliminary amendment.
14. [X] A substitute specification.
15. [ ] A change of power of attorney and/or address letter.
16. [X] Other items or information:

    Copy of International Preliminary Examination Report.
    Copy of Internation Search Report.

U.S. APPLICATION NO. (if known, see 37 CFR 1.5) 09/936277	INTERNATIONAL APPLICATION NO. PCT/CH00/00040	ATTORNEY'S DOCKET NUMBER FRR-12655

17. [x] The following fees are submitted:

	CALCULATIONS	PTO USE ONLY
BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)):		
Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO **$1000.00**		
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO **$860.00**		
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO **$710.00**		
International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4) **$690.00**		
International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4) **$100.00**		
ENTER APPROPRIATE BASIC FEE AMOUNT =	$ 860.00	
Surcharge of **$130.00** for furnishing the oath or declaration later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 CFR 1.492(e)).	$ 0.00	

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	7 - 20 =	0	X **$18.00**	$ 0.00	
Independent claims	1 - 3 =	0	X **$80.00**	$ 0.00	
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ **$270.00**	$ 0.00	
TOTAL OF ABOVE CALCULATIONS =				$ 860.00	
[ ] Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2.				$	
SUBTOTAL =				$ 860.00	
Processing fee of **$130.00** for furnishing the English translation later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 CFR 1.492(f)). +				$ 0.00	
TOTAL NATIONAL FEE =				$ 860.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **$40.00** per property +				$ 0.00	
TOTAL FEES ENCLOSED =				$ 860.00	
				Amount to be refunded:	$
				charged:	$

a. [x] A check in the amount of $ 860.00 to cover the above fees is enclosed.

b. [ ] Please charge my Deposit Account No. 18-0160 in the amount of $________ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. [x] The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 18-0160. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO

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34732

REGISTRATION NUMBER

Application Data Sheet
Application Information

Application Type::	Regular
Subject Matter::	Utility
Suggested classification::	
Suggested Group Art Unit::	
CD-ROM or CD-R?::	None
Number of CD disks::	0
Number of copies of CDs::	0
Sequence submission?::	No
Computer Readable Form (CRF)?::	No
Number of copies of CRF::	0
Title ::	ACTIVE ELECTRO-OPTIC FILTERING DEVICE AND METHOD FOR OPERATING SAME
Attorney Docket Number::	FRR-12655
Request for Early Publication?::	No
Request for Non-Publication?::	No
Suggested Drawing Figure::	Fig. 1
Total Drawing Sheets::	2
Small Entity?::	No
Latin name::	
Variety denomination name::	
Petition included?::	No
Petition Type::	
Licensed US Govt. Agency::	
Contract or Grant Numbers::	
Secrecy Order in Parent Appl.?::	No

Applicant Information

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Representative Information

Representative Customer Number::	007609	

Domestic Priority Information

Application::	Continuity Type::	Parent Application::	Parent Filing Date::
This Application	National Stage of	PCT/CH00/00040	01/28/00

Foreign Priority Information

Country::	Application number::	Filing Date::	Priority Claimed::
Switzerland	458/99	03/11/99	Yes

09/936277

JC03 Rec'd PCT/PTO 10 SEP 2001

Assignee Information

Assignee name::	OPTREL AG
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State or Province of mailing address::	
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09936277 .091001

09/936277

JC03 Rec'd PCT/PTO 10 SEP 2001

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Leo Keller and Emil Ackermann	
Serial No.:	N/A	Art Unit: N/A
Filing Date:	Herewith	
International Application No.:	PCT/CH00/00040	
International Filing Date:	January 28, 2000	
Title:	ACTIVE ELECTRO-OPTIC FILTERING DEVICE AND METHOD FOR OPERATING SAME	
Examiner:	N/A	
Docket No.:	FRR-12655	

PRELIMINARY AMENDMENT "A"

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

Please amend the above-identified application, prior to examination thereof, in the following manner.

Express Mail Label No.: EL653252170US

IN THE CLAIMS:

Please amend the claims as follows:

1. (Amended) A process for operation of an active electro-optical filtering device with an active optical filter element (1), wherein the optical filter element (1) is driven with anti-polar drive pulses, whereby the optical filter element (1) is short-circuited between two successive drive pulses.

2. (Amended) The process in accordance with claim 1, wherein short-circuit times (t_{s1}, t_{s2}) are shorter by factors in the order of magnitude of 10^3 to 10^7 than time durations (t_+, t_-) of the drive pulses.

3. (Amended) The process in accordance with claim 1, wherein a framework frequency (f) of the drive pulses amounts to between 0.01 and 1 Hz.

4. (Amended) The process in accordance with claim 1, wherein an operating voltage (U_{LC}) is applied to the optical filter element at which operating voltage (U_{LC}) the scattered light term (φ_{1R}) of the optical filter element (1) is smaller than or equal to a transmission term of the optical filter element (1).

5. (Amended) The process in with claim 4, wherein the operating voltage (U_{LC}) lies several times above a Fréedericksz-threshold of the optical filter element (1).

6. (Amended) An active electro-optical filtering device that is adapted for operation in

accordance with the process of claim 1, said filtering device containing at least one active optical filter element (1) with a liquid crystal, electronic means (2) for driving the at least one active filter element (1), a light sensor (4) operating in conjunction with the electronic means (2) and electric power supply means (5), in particular a solar cell, for the electronic means (2) and the at least one optical filter element (1), and wherein the liquid crystal is implemented in accordance with a technology selected from the group consisting of: TN-technology, STN-technology, dichroic technology, ferro-electric technology and π-Mode-LCD-technology.

7. (Amended) The drive circuit (2) for an active electro-optical filtering device in accordance with claim 6, further comprising a switch (S_1) with which the active optical filter element (1) can be short-circuited.

IN THE ABSTRACT:

Please replace the original abstract with the following new abstract of the disclosure:

ABSTRACT OF THE DISCLOSURE

An active optical filtering device useful for a dazzle-protection device in welding protection masks, helmets and goggles, is equipped with a light protection filter having at least one active optical filter element and with an electronic circuit for controlling the active filter element. The device also has a light sensor operating in conjunction with the electronic circuit and an electric power supply, in particular a solar cell, for the electronic circuit and the active filter element. The driving circuit for the active filter element is implemented such that, in the range of the framework frequency (1/T) of 0.01 to 1 Hz, the load capacitor is briefly completely discharged. As a result, the power demand is halved in comparison with known circuits. Simultaneously the operating voltage (U) is situated within a range, which is quantitatively defined and within which the scattered light proportion of the liquid crystal display utilized is minimal.

REMARKS

Attached hereto is a marked-up version of the changes made to the application by the present Amendment. If clarification of the amendment or application is desired, or if issues are present which the Examiner believes may be quickly resolved, the Examiner is invited to initiate a telephone interview with the undersigned attorney to expedite prosecution of the present application.

If there are any additional fees resulting from this communication, please charge same to our Deposit Account No. 18-0160, our Order No. FRR-12655.

Respectfully submitted,

RANKIN, HILL, PORTER & CLARK LLP

By: ______________________
David E. Spaw, Reg. No. 34732

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Attachment: Marked-up version of Amendments

Marked-up Version of Amendment

IN THE CLAIMS:

The claims have been amended as follows:

1. (Amended) ~~[Process]~~ A process for ~~[the]~~ operation of an active electro-optical filtering device with an active optical filter element (1), ~~[characterized in that]~~ wherein the optical filter element (1) is driven with anti-polar drive pulses, whereby the optical filter element (1) is short-circuited between two successive drive pulses.

2. (Amended) ~~[Process]~~ The process in accordance with claim 1, ~~[characterized in that the]~~ wherein short-circuit times (t_{s1}, t_{s2}) are shorter~~[, preferably]~~ by factors in the order of magnitude of 10^3 to 10^7~~[-]~~ than ~~[the]~~ time durations (t_+, t_-) of the drive pulses.

3. (Amended) ~~[Process]~~ The process in accordance with claim 1 ~~[or 2, characterized in that the]~~, wherein a framework frequency (f) of the drive pulses amounts to between 0.01 and 1 Hz.

4. (Amended) ~~[Process for the operation of an active electro-optical filtering device with an active optical filter element (1), in preference in accordance with one of the claims 1-3, characterized in that]~~ The process in accordance with claim 1, wherein an operating voltage (U_{LC}) is applied to the optical filter element at which operating voltage (U_{LC}) the scattered light term (φ_{1R}) of the optical filter element (1) is smaller than or equal to ~~[the]~~ a transmission term of the optical filter element (1).

5. (Amended) ~~[Process in accordance]~~ The process in with claim 4, ~~[characterized in that]~~ wherein the operating voltage (U_{LC}) lies several times above ~~[the]~~ a Fréedericksz-threshold of the optical filter element (1).

6. (Amended) ~~[Active]~~ An active electro-optical filtering device~~[, which can be operated with the process in accordance with one of the claims 1-5,]~~ that is adapted for operation in accordance with the process of claim 1, said filtering device containing at least one active optical filter element (1) with a liquid crystal, electronic means (2) for driving the at

least one active filter element (1), a light sensor (4) operating in conjunction with the electronic means (2) and electric power supply means (5), in particular a solar cell, for the electronic means (2) and the at least one optical filter element (1), [~~characterized in that~~] and wherein the liquid crystal is implemented in accordance with [~~one of the following technologies~~] a technology selected from the group consisting of: TN-technology, STN-technology, dichroic technology, ferro-electric technology [~~or~~] and π-Mode-LCD-technology.

7. (Amended) [~~Drive~~] The drive circuit (2) for an active electro-optical filtering device in accordance with claim 6, [~~characterized by~~] further comprising a switch (S_1)[~~,~~] with which the active optical filter element (1) can be short-circuited.

IN THE ABSTRACT:

The Abstract of the Disclosure has been amended as follows:

ABSTRACT OF THE DISCLOSURE

An [~~The~~] active optical filtering device[~~, which is suitable in particular as a dazzleprotection device for utilization~~] useful for a dazzle-protection device in welding protection masks, [~~-~~]helmets [~~or -~~]and goggles, is equipped [~~in an as such known manner~~] with a light protection filter [~~with~~] having at least one active optical filter element and with an electronic circuit for controlling the active filter element [~~as well as with~~]. The device also has a light sensor operating in conjunction with the electronic circuit and an electric power supply, in particular a solar cell, for the electronic circuit and the active filter element. The driving circuit for the active filter element is implemented [~~in~~] such [~~a manner,~~] that, in the range of the framework frequency (1/T) of 0.01 to 1 Hz, the load capacitor is briefly completely discharged[~~, as~~]. As a result [~~of which~~], the power demand is halved in comparison with known circuits. Simultaneously the operating voltage (U) is situated within a range, which is quantitatively defined and within which the scattered light proportion of the liquid crystal

display utilized is minimal [~~as a result of this definition.~~].

[~~(Figure 3)~~]

21PRTS

ACTIVE ELECTRO-OPTICAL FILTERING DEVICE AND PROCESS FOR OPERATING IT

The invention concerns an active electro-optical filtering device and a process for operating it in accordance with the generic terms of the independent claims. The filtering device is suitable in particular as a dazzle protection device for utilization in welding protection masks, -helmets or -goggles.

Filtering devices of this type are known, e.g., from the documents WO 97/15254, US-5,315,099 or EP-0 550 384. As active filter elements, they typically contain at least one liquid crystal cell (liquid-crystal-cell, LC-cell), which blocks the light transmission to a greater or lesser extent, as soon as a light sensor is impinged with a light intensity which exceeds a predefined threshold level. The utilization of such filtering devices is many and diverse; a typical example is the use as viewing window for welding protection masks, -helmets and -goggles.

The filtering devices described in the documents mentioned consist of active filter elements, for example made of 0-90° rotating nematic liquid crystal elements, which are located between two crossed polarizers. They are operated with an operating voltage which lies several times above the Fréedericksz threshold. Designated as Fréedericksz-threshold is the driving voltage of a liquid crystal cell at which a first optical activity of the cell can be observed. The choice of a higher operating voltage is justified in the above mentioned documents with a reduction of the scattered light

produced, a reduced dependence on temperature of the electro-optical effect and the creation of an optical transmission of less than 1 %.

The driving frequency of active filter elements like this for reasons of a low power demand lies between 0 and 32 Hz. Mentioned as the main reason for the limited availability of electric supply power is the operation of the filter elements using electricity from support/buffer batteries and solar cells. While continuous direct current operation today still damages liquid crystal cells through electrolysis and ion migration or else strongly impairs their optical performance capacity, by continuous improvement of the insulating layers, by the reduction of impurities and by the achievement of higher electric conductance values of the liquid crystal substances utilized significant progress has been achieved. The choice of an as low as possible driving frequency is strived for, because the drive frequency has a linear effect on the power demand of a liquid crystal cell. It would, however, be desirable to reduce the power demand even further.

Two values characteristic for such electro-optical filtering devices are of particular significance in this context: the transmission and the scattering. Requirements of these values are laid down in various product standards, e.g., EN 166, EN 167, EN 169 or EN 379. The European standard EN 169 prescribes within which range the transmission T may lie in case of various welding processes. In doing so, a protection level number

$$N = 1 - (7/3)\log T \qquad (1)$$

is introduced. Permissible scattered light for active filter elements are defined in the European standard EN 379. In doing so, the reduced scattered light coefficient is defined as follows:

$$l^* = (1/\omega)(\varphi_{1R} - \varphi_{2R})/\varphi_{1L} \quad , \tag{2}$$

whereby

ω	is the spatial angle,
$(\varphi_{1R} - \varphi_{2R})$	is the scattered light flow of the test sample in the defined spatial angle (minus the scattered light proportion of the measuring installation) and
φ_{1L}	is the unscattered light flow of the test sample (zero diffraction order).

In the case of known electro-optical filtering devices, the optical quality is strongly impaired by scattered light. The light scatter on an LC-cell has various causes: amongst others, particles enclosed in the LC-cell, differing layer thicknesses, scratches, edges and/or spacers between the glass plates enclosing the liquid crystal.

It is the task of the invention to create an active electro-optical filtering device and to indicate a process for its operation, in the case of which an as low as possible operating voltage is required and nonetheless a good optical quality, in particular an as small as possible impairment of it due to light scattering, is achieved. The task is solved by the filtering device and by the process as defined in the independent claims.

For the reduction of the power demand of the liquid crystal cell, the electro-optical filtering device in accordance with the invention is in preference equipped with a special driving circuit. The driving circuit in accordance with the invention contains a switch, which in every half-period short-circuits the liquid crystal cell for a certain time period. Therefore neither a continuous trigger circuit nor a continually changing drive voltage is chosen. The drive in accordance with the invention differs from the state of the art by the insertion of an active flank and a drive process, which instead

of to a continuous frequency, corresponds rather more to a pulse width modulation. The framework frequency of the driving pulses lies in the range of 0.01 to 1 Hz. The energy requirement with this process is halved in comparison with the state of the art, which represents an enormous progress.

The invention presented here utilizes an operating voltage which is unequivocally defined. On the one hand, it is several times above the Fréedericksz-threshold, in order to achieve the optical density prescribed in the product standard EN 169. In addition, the operating voltage is defined in such a manner, that it lies at the voltage, at which the light scattered by the LCD display is minimal.

The definition of the operating voltage in accordance with the invention consists in the finding that a minimum of scattered light is achieved, when in the scattered light equation (2) the numerator (essentially φ_{1R}) is smaller or else the same value as the denominator (φ_{1L}). In other words this signifies: if the scattered light proportion φ_{1R} in the operating point of the liquid crystal display is adjusted to be smaller than or equal to the residual transmission $T = 10^{(3/7)(1-N)}$, then the operating voltage has been selected as optimized with respect to scattered light. Operating frequencies defined in such a manner according to experience lie in the range of 10 to 50 Volt. The adjusting of the residual transmission can, for example, be solved with a small offset of the polarizer orientation or with an adaptation of the polarization efficiency. The scattered light influence of the measuring installation (φ_{2R}) has been neglected in the above discussion.

In the following, the invention is described in detail on the basis of Figures. These illustrate:

Fig. 1 a filtering device in accordance with the invention executed as a dazzle-protection device,

Fig. 2 an equivalent circuit diagram of a control circuit in accordance with the invention,

Fig. 3 the operating voltage in function of time for a preferred embodiment of the operating process and

Fig. 4 the reduced radiant luminance in function of the operating voltage.

In **Figure 1,** a filtering device in accordance with the invention designed as a dazzle-protection device is illustrated. It contains at least one active optical filter element 1 with a liquid crystal. The liquid crystal is implemented in accordance with one of the following technologies: TN-technology, STN-technology, dichroic technology, ferroelectric technology or π-Mode-LCD-technology. Apart from this, the filtering device contains electronic means 2 for driving the active filter element 1. At least one light sensor 4 acts in conjunction with the electronic means 2. Brought to the electronic means 2 are, for example, output signals of the light sensors 4 for the purpose of controlling, resp., closed-circuit controlling the operating voltage of the filter element. For the electronic means 2, the optical filter element 1 and possibly the light sensors 4, electric power supply means 5 are foreseen. These can be implemented, e.g., as solar cells.

It is advantageous to equip the electronic means 2 with a driving circuit, as is schematically illustrated in **Figure 2.** With this, the power demand of the liquid crystal cell 1 can be significantly reduced. The liquid crystal on the equivalent circuit diagram of Fig. 2 is represented by a resistor R_{LC} and a capacitor C_{LC}. Other resistors in the circuit are combined in the resistors R_{S1} and R_{S2}. An alternating current source 21

supplies an alternating current $U_{\approx}$ with a framework frequency f of typically 0.01 to 1 Hz. The drive circuit in accordance with the invention contains a switch S_1, which short-circuits the liquid crystal cell for a certain time period t_s. This effects the complete discharge of the capacitor C_{LC}. The energy required for the anti-polar charging of the capacitor C_{LC} with this drive circuit is therefore halved in comparison with the state of the art.

Figure 3 shows the operating voltage U(t) supplied by the drive circuit in accordance with Fig. 2 in function of the time t. In a time period T with a typical duration of 1 to 100 sec, initially during a first time interval t_+ a, for example, positive voltage $+|U_{LC}|$ is applied to the liquid crystal cell 1. Thereafter, e.g., by closing the switch S_1 (refer to Fig. 2), during a second time interval t_{S1} the liquid crystal cell 1 is short-circuited. During a third time interval t_- thereupon a, for example, negative voltage $-|U_{LC}|$ is applied to the liquid crystal cell 1, whereupon during a fourth time interval t_{S2} once again a short-circuit takes place. In this manner, therefore active flanks 31, 32 are inserted into the course of the operating voltage U(t). This drive process in accordance with the invention corresponds most likely to a pulse width modulation. The framework frequency f = 1/T of the driving pulses lies in the range of 0.01 to 1 Hz. It has to be observed, that the time intervals in Fig. 3 for reasons of clarity are not depicted to scale: While the first time interval t_+ and the third time interval t_- have typical lengths of 0.5 to 50 sec, typically the lengths of the second time interval t_{S1} and of the fourth time interval t_{S2} lie in the range of microseconds to milliseconds. The short-circuit times t_{S1}, t_{S2} are therefore shorter than the drive times t_+, t_- by factors in an order of magnitude of 10^3 to 10^7.

Figure 4 illustrates a typical dependence of the reduced radiant luminance coefficient $l^*(U)$ (refer to equation (2)) in function of the operating voltage U. The analysis of the scatter phenomenons on a liquid crystal cell 1 is important for the comprehension of the invention. Causes of the light scattering are, for example, particles en-

closed in the liquid crystal cell 1, differing layer thicknesses, scratches, edges and/or spacers between the two glass plates enclosing the liquid crystal. In the case of scattered light, one can differentiate between a static proportion l^*_s and a dynamic proportion l^*_d. The static scattered light proportion l^*_s can by means of suitable technical measures be reduced to such an extent, that the user of an active dazzle-protection filter does not have to be subject to an impairment of the image quality (scattered light class 1, in accordance with European standard EN 379). Completely different is the situation in the case of the dynamic, voltage-dependent scattered light proportion l^*_d. Around the scattered light centres mentioned above, when an operating voltage U is applied, a local orientation disruption is produced. The foreign substance – or the edge – causing the scattered light centre disrupts the homogeneous, chiral orientation of the liquid crystal molecules. These local orientation disruptions are to a great extent responsible for the voltage-dependent scattered light proportion l^*_d. With a higher operating voltage U, the liquid crystal molecules are aligned more and more parallel to the field strength vector and therefore the local orientation disruption is made to disappear.

The reduced radiant luminance coefficient l^* illustrated in Fig. 4, in accordance with the equation (2) is essentially the ratio of the scattered light flow φ_{1R} and the unscattered light flow φ_{1L}. In the case of the curve $l^*(U)$, three ranges can be differentiated between.

I. For low operating voltages U, φ_{1R} is $< \varphi_{1L}$, therefore l^* is < 1. In this first range I, φ_{1L} is reduced more strongly with increasing U than φ_{1R}, for which reason $l^*(U)$ increases monotonously.

II. For medium operating voltages U, φ_{1R} is $\approx \varphi_{1L}$, therefore l^* is ≈ 1. In this second range II, $l^*(U)$ is approximately constant.

III. For high operating voltage U, once again $\varphi_{1R} < \varphi_{1L}$ is applicable, therefore $l^* < 1$. In this third range III, φ_{1L} is reduced only a little with increasing U or is approximately constant, while on the contrary φ_{1R} for the reasons mentioned above still reduces, for which reason $l^*(U)$ is monotonously reduced.

In accordance with the invention, the operating voltage $U = U_{LC}$ is selected in such a manner, that the following conditions are fulfilled:

a) The required transmission is achieved;

b) The reduced radiant luminance coefficient l^* is minimal.

The operating voltage U_{LC} is determined from this as follows. The condition a) defines a band on the U-axis, in which the operating voltage U_{LC} has to be, in order to achieve the required transmission. In this band thereupon, in accordance with condition b) the operating voltage U_{LC} is unequivocally determined, so that l^* becomes minimal. Normally the operating point U_{LC} is situated in the third range III of the curve $l^*(U)$.

If so required, the transmission can be adjusted by a slight rotation relative to one another of the polarizers or by an adaptation of the polarizer efficiency.

CLAIMS

1. Process for the operation of an active electro-optical filtering device with an active optical filter element (1), **characterized in that** the optical filter element (1) is driven with anti-polar drive pulses, whereby the optical filter element (1) is short-circuited between two successive drive pulses.

2. Process in accordance with claim 1, **characterized in that** the short-circuit times (t_{S1}, t_{S2}) are shorter, preferably by factors in the order of magnitude of 10^3 to 10^7, than the time durations (t_+, t_-) of the drive pulses.

3. Process in accordance with claim 1 or 2, **characterized in that** the framework frequency (f) of the drive pulses amounts to between 0.01 and 1 Hz.

4. Process for the operation of an active electro-optical filtering device with an active optical filter element (1), in preference in accordance with one of the claims 1-3, **characterized in that** an operating voltage (U_{LC}) is applied to the optical filter element at which operating voltage (U_{LC}) the scattered light term (φ_{1R}) of the optical filter element (1) is smaller than or equal to the transmission term of the optical filter element (1).

5. Process in accordance with claim 4, **characterized in that** the operating voltage (U_{LC}) lies several times above the Fréedericksz-threshold of the optical filter element (1).

6. Active electro-optical filtering device, which can be operated with the process in accordance with one of the claims 1-5, containing at least one active optical filter element (1) with a liquid crystal, electronic means (2) for driving the at least one active filter element (1), a light sensor (4) operating in conjunction with the electronic means (2) and electric power supply means (5), in particular a solar cell, for the electronic means (2) and the at least one optical filter element (1), **characterized in that** the liquid crystal is implemented in accordance with one of the following technologies: TN-technology, STN-technology, dichroic technology, ferro-electric technology or π-Mode-LCD-technology.

7. Drive circuit (2) for an active electro-optical filtering device in accordance with claim 6, **characterized by** a switch (S_1), with which the active optical filter element (1) can be short-circuited.

09/936277

JC03 Rec'd PCT/PTO 10 SEP 2001

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Leo Keller and Emil Ackermann
Serial No.:	N/A
Filed:	Herewith
International Application No.:	PCT/CH00/00040
International Filing Date:	January 28, 2000
Title:	ACTIVE ELECTRO-OPTIC FILTERING DEVICE AND METHOD FOR OPERATING SAME
Docket No.:	FRR-12655

SUBSTITUTE SPECIFICATION
(Filed under §1.125(b))

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

Enclosed herewith is a substitute specification for filing in the above-identified application. The undersigned hereby certifies that the substitute specification includes no new matter. A marked-up copy of the substitute specification showing the matter being added to and the matter being deleted from the specification of record is also included.

If there are any additional fees resulting from this communication, please charge same to our Deposit Account No. 18-0160, our Order No. FRR-12655.

Respectfully submitted,

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ACTIVE ELECTRO-OPTICAL FILTERING DEVICE AND PROCESS FOR OPERATING IT

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

[0001] The invention concerns an active electro-optical filtering device and a process for operating it in accordance with the generic terms of the independent claims. The filtering device is suitable in particular as a dazzle protection device for utilization in welding protection masks, -helmets or -goggles.

DESCRIPTION OF RELATED ART

[0002] Filtering devices of the aforementioned type are known, e.g., from the documents WO 97/15254, US-5,315,099 or EP-0 550 384. As active filter elements, they typically contain at least one liquid crystal cell (liquid-crystal-cell, LC-cell), which blocks the light transmission to a greater or lesser extent, as soon as a light sensor is impinged with a light intensity which exceeds a predefined threshold level. The utilization of such filtering devices is many and diverse; a typical example is the use as viewing window for welding protection masks, -helmets and -goggles.

[0003] The filtering devices described in the documents mentioned consist of active filter elements, for example made of 0-90° rotating nematic liquid crystal elements, which are located between two crossed polarizers. They are operated with an operating voltage which lies several times above the Fréedericksz threshold. Designated as Fréedericksz-threshold is the driving voltage of a liquid crystal cell at which a first optical activity of the cell can be observed. The choice of a higher operating voltage is justified in the above mentioned documents with a reduction of the scattered light produced, a reduced dependence on temperature of the electro-optical effect and the creation of an optical transmission of less than 1 %.

[0004] The driving frequency of active filter elements like this, for reasons of a low power

demand, lies between 0 and 32 Hz. Mentioned as the main reason for the limited availability of electric supply power is the operation of the filter elements using electricity from support/buffer batteries and solar cells. While continuous direct current operation today still damages liquid crystal cells through electrolysis and ion migration or else strongly impairs their optical performance capacity, by continuous improvement of the insulating layers, by the reduction of impurities and by the achievement of higher electric conductance values of the liquid crystal substances utilized significant progress has been achieved. The choice of an as low as possible driving frequency is strived for, because the drive frequency has a linear effect on the power demand of a liquid crystal cell. It would, however, be desirable to reduce the power demand even further.

[0005] Two values characteristic for such electro-optical filtering devices are of particular significance in this context: the transmission and the scattering. Requirements of these values are laid down in various product standards, e.g., EN 166, EN 167, EN 169 or EN 379. The European standard EN 169 prescribes within which range the transmission T may lie in case of various welding processes. In doing so, a protection level number

[0006] $N = 1 - (7/3)\log T$ (1)

[0007] is introduced. Permissible scattered light for active filter elements are defined in the European standard EN 379. In doing so, the reduced scattered light coefficient is defined as follows:

[0008] $l^* = (1/\omega)(\varphi_{1R} - \varphi_{2R})/\varphi_{1L}$, (2)

[0009] whereby

[0010] ω is the spatial angle,

[0011] $(\varphi_{1R} - \varphi_{2R})$ is the scattered light flow of the test sample in the defined spatial angle (minus the scattered light proportion of the measuring installation) and

[0012] φ_{1L} is the unscattered light flow of the test sample (zero diffraction order).

[0013] In the case of known electro-optical filtering devices, the optical quality is strongly impaired by scattered light. The light scatter on an LC-cell has various causes: among others,

particles enclosed in the LC-cell, differing layer thicknesses, scratches, edges and/or spacers between the glass plates enclosing the liquid crystal.

[0014] US-3,961,840 shows a device for triggering of display elements for watches and portable computers. These display elements are not optical filtering elements in the sense of the invention disclosed here.

[0015] US-4,279,474 shows sunglasses with LCD-elements. The LCD-elements are for shading the glasses.

SUMMARY OF THE INVENTION

[0016] It is an object of the invention to create an active electro-optical filtering device and to indicate a process for its operation, in the case of which an as low as possible operating voltage is required and nonetheless a good optical quality, in particular an as small as possible impairment of it due to light scattering, is achieved.

[0017] For reducing the power demand of the liquid crystal cell, the electro-optical filtering device in accordance with the invention is in preference equipped with a special driving circuit. The driving circuit in accordance with the invention contains a switch, which in every half-period short-circuits the liquid crystal cell for a certain time period. Therefore, neither a continuous trigger circuit nor a continually changing drive voltage is chosen. The drive in accordance with the invention differs from the state of the art by the insertion of an active flank and a drive process, which instead of to a continuous frequency, corresponds rather more to a pulse width modulation. The framework frequency of the driving pulses lies in the range of 0.01 to 1 Hz. The energy requirement with this process is halved in comparison with the state of the art, which represents an enormous progress.

[0018] The invention presented here utilizes an operating voltage which is unequivocally defined. On the one hand, it is several times above the Fréedericksz-threshold, in order to achieve the optical density prescribed in the product standard EN 169. In addition, the operating voltage is defined in such a manner, that it lies at the voltage, at which the light scattered by the LCD display is minimal.

[0019] The definition of the operating voltage in accordance with the invention consists in

the finding that a minimum of scattered light is achieved, when in the scattered light equation (2) the numerator (essentially φ_{1R}) is smaller or else the same value as the denominator (φ_{1L}). In other words this signifies: if the scattered light proportion φ_{1R} in the operating point of the liquid crystal display is adjusted to be smaller than or equal to the residual transmission $T = 10^{(3/7)(1-N)}$, then the operating voltage has been selected as optimized with respect to scattered light. Operating frequencies defined in such a manner according to experience lie in the range of 10 to 50 Volt. The adjusting of the residual transmission can, for example, be solved with a small offset of the polarizer orientation or with an adaptation of the polarization efficiency. The scattered light influence of the measuring installation (φ_{2R}) has been neglected in the above discussion.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] These and further features of the invention will be apparent with reference to the following description and drawings, wherein:

[0021] Fig. 1 is a filtering device in accordance with the invention executed as a dazzle protection device,

[0022] Fig. 2 is an equivalent circuit diagram of a control circuit in accordance with the invention,

[0023] Fig. 3 is the operating voltage in function of time for a preferred embodiment of the operating process and

[0024] Fig. 4 shows the reduced radiant luminance in function of the operating voltage.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0025] In Figure 1, a filtering device in accordance with the invention designed as a dazzle protection device is illustrated. It contains at least one active optical filter element 1 with a liquid crystal. The liquid crystal is implemented in accordance with one of the following technologies: TN-technology, STN-technology, dichroic technology, ferro-electric technology or π-Mode-LCD-technology. Apart from this, the filtering device contains electronic means 2

for driving the active filter element 1. At least one light sensor 4 acts in conjunction with the electronic means 2. Brought to the electronic means 2 are, for example, output signals of the light sensors 4 for the purpose of controlling, resp., closed-circuit controlling the operating voltage of the filter element. For the electronic means 2, the optical filter element 1 and possibly the light sensors 4, electric power supply means 5 are foreseen. These can be implemented, for example., as solar cells.

[0026] It is advantageous to equip the electronic means 2 with a driving circuit, as is schematically illustrated in Figure 2. With this, the power demand of the liquid crystal cell 1 can be significantly reduced. The liquid crystal on the equivalent circuit diagram of Fig. 2 is represented by a resistor R_{LC} and a capacitor C_{LC}. Other resistors in the circuit are combined in the resistors R_{SI} and R_{S2}. An alternating current source 21 supplies an alternating current $U_{\approx}$ with a framework frequency f of typically 0.01 to 1 Hz. The drive circuit in accordance with the invention contains a switch S_1, which short-circuits the liquid crystal cell for a certain time period t_s. This effects the complete discharge of the capacitor C_{LC}. The energy required for the anti-polar charging of the capacitor C_{LC} with this drive circuit is therefore halved in comparison with the state of the art.

[0027] Figure 3 shows the operating voltage U(t) supplied by the drive circuit in accordance with Fig. 2 in function of the time t. In a time period T with a typical duration of 1 to 100 sec, initially during a first time interval t_+ a, for example, positive voltage $+|U_{LC}|$ is applied to the liquid crystal cell 1. Thereafter, e.g., by closing the switch S_1 (refer to Fig. 2), during a second time interval t_{SI} the liquid crystal cell 1 is short-circuited. During a third time interval t_- thereupon a, for example, negative voltage $-|U_{LC}|$ is applied to the liquid crystal cell 1, whereupon during a fourth time interval t_{S2} once again a short-circuit takes place. In this manner, therefore active flanks 31, 32 are inserted into the course of the operating voltage U(t). This drive process in accordance with the invention corresponds most likely to a pulse width modulation. The framework frequency f = 1/T of the driving pulses lies in the range of 0.01 to 1 Hz. It has to be observed that the time intervals in Fig. 3 for reasons of clarity are not depicted to scale: While the first time interval t_+ and the third time interval t_- have typical lengths of 0.5 to 50 sec, typically the lengths of the second time interval t_{SI} and of the fourth time interval t_{S2} lie in the range of microseconds to milliseconds. The short-circuit times t_{SI},

t_{S2} are therefore shorter than the drive times t_+, t_- by factors having an order of magnitude of 10^3 to 10^7.

[0028] Figure 4 illustrates a typical dependence of the reduced radiant luminance coefficient $l^*(U)$ (refer to equation (2)) in function of the operating voltage U. The analysis of the scatter phenomenons on a liquid crystal cell 1 is important for the comprehension of the invention. Causes of the light scattering are, for example, particles enclosed in the liquid crystal cell 1, differing layer thicknesses, scratches, edges and/or spacers between the two glass plates enclosing the liquid crystal. In the case of scattered light, one can differentiate between a static proportion l^*_S and a dynamic proportion l^*_d. The static scattered light proportion l^*_S can by means of suitable technical measures be reduced to such an extent that the user of an active dazzle-protection filter does not have to be subject to an impairment of the image quality (scattered light class 1, in accordance with European standard EN 379). Completely different is the situation in the case of the dynamic, voltage-dependent scattered light proportion l^*_d. Around the scattered light centers mentioned above, when an operating voltage U is applied, a local orientation disruption is produced. The foreign substance - or the edge - causing the scattered light center disrupts the homogeneous, chiral orientation of the liquid crystal molecules. These local orientation disruptions are to a great extent responsible for the voltage-dependent scattered light proportion l^*_d. With a higher operating voltage U, the liquid crystal molecules are aligned more and more parallel to the field strength vector and therefore the local orientation disruption is made to disappear.

[0029] The reduced radiant luminance coefficient l^* illustrated in Fig. 4, in accordance with the equation (2) is essentially the ratio of the scattered light flow φ_{1R} and the unscattered light flow φ_{1L}. In the case of the curve $l^*(U)$, three ranges can be differentiated between.

[0030] I. For low operating voltages U, φ_{1R} is $< \varphi_{1L}$, therefore l^* is < 1. In this first range I, φ_{1L} is reduced more strongly with increasing U than φ_{1R}, for which reason $l^*(U)$ increases monotonously.

[0031] II. For medium operating voltages U, φ_{1R} is $\approx \varphi_{1L}$, therefore 1^* is ≈ 1. In this second range II, $l^*(U)$ is approximately constant.

[0032] III. For high operating voltage U, once again $\varphi_{1R} < \varphi_{1L}$ is applicable, therefore $l^* < 1$. In this third range III, φ_{1L} is reduced only a little with increasing U or is

approximately constant, while on the contrary φ_{1R} for the reasons mentioned above still reduces, for which reason $l^*(U)$ is monotonously reduced.

[0033] In accordance with the invention, the operating voltage $U = U_{LC}$ is selected in such a manner that the following conditions are fulfilled:

[0034] a) The required transmission is achieved;

[0035] b) The reduced radiant luminance coefficient l^* is minimal.

[0036] The operating voltage U_{LC} is determined from this as follows. The condition a) defines a band on the U-axis in which the operating voltage U_{LC} has to be in order to achieve the required transmission. In this band thereupon, in accordance with condition b), the operating voltage U_{LC} is unequivocally determined, so that l^* becomes minimal. Normally the operating point U_{LC} is situated in the third range III of the curve $l^*(U)$.

[0037] If so required, the transmission can be adjusted by a slight rotation relative to one another of the polarizers or by an adaptation of the polarizer efficiency.

[0038] The present invention has been described herein with particularity, but it is noted that the scope of the invention is not limited thereto. Rather, the present invention is considered to be possible of numerous modifications, alterations, and combinations of parts and, therefore, is only defined by the claims appended hereto.

ACTIVE ELECTRO-OPTICAL FILTERING DEVICE AND PROCESS FOR OPERATING IT

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

[0001] The invention concerns an active electro-optical filtering device and a process for operating it in accordance with the generic terms of the independent claims. The filtering device is suitable in particular as a dazzle protection device for utilization in welding protection masks, -helmets or -goggles.

DESCRIPTION OF RELATED ART

[0002] Filtering devices of ~~[this]~~ the aforementioned type are known, e.g., from the documents WO 97/15254, US-5,315,099 or EP-0 550 384. As active filter elements, they typically contain at least one liquid crystal cell (liquid-crystal-cell, LC-cell), which blocks the light transmission to a greater or lesser extent, as soon as a light sensor is impinged with a light intensity which exceeds a predefined threshold level. The utilization of such filtering devices is many and diverse; a typical example is the use as viewing window for welding protection masks, -helmets and -goggles.

[0003] The filtering devices described in the documents mentioned consist of active filter elements, for example made of 0-90° rotating nematic liquid crystal elements, which are located between two crossed polarizers. They are operated with an operating voltage which lies several times above the Fréedericksz threshold. Designated as Fréedericksz-threshold is the driving voltage of a liquid crystal cell at which a first optical activity of the cell can be observed. The choice of a higher operating voltage is justified in the above mentioned documents with a reduction of the scattered light produced, a reduced dependence on temperature of the electro-optical effect and the creation of an optical transmission of less than 1 %.

[0004] The driving frequency of active filter elements like this, for reasons of a low power

demand, lies between 0 and 32 Hz. Mentioned as the main reason for the limited availability of electric supply power is the operation of the filter elements using electricity from support/buffer batteries and solar cells. While continuous direct current operation today still damages liquid crystal cells through electrolysis and ion migration or else strongly impairs their optical performance capacity, by continuous improvement of the insulating layers, by the reduction of impurities and by the achievement of higher electric conductance values of the liquid crystal substances utilized significant progress has been achieved. The choice of an as low as possible driving frequency is strived for, because the drive frequency has a linear effect on the power demand of a liquid crystal cell. It would, however, be desirable to reduce the power demand even further.

[0005] Two values characteristic for such electro-optical filtering devices are of particular significance in this context: the transmission and the scattering. Requirements of these values are laid down in various product standards, e.g., EN 166, EN 167, EN 169 or EN 379. The European standard EN 169 prescribes within which range the transmission T may lie in case of various welding processes. In doing so, a protection level number

[0006] $N = 1 - (7/3)\log T$ (1)

[0007] is introduced. Permissible scattered light for active filter elements are defined in the European standard EN 379. In doing so, the reduced scattered light coefficient is defined as follows:

[0008] $l^* = (1/\omega)(\varphi_{1R} - \varphi_{2R})/\varphi_{1L}$, (2)

[0009] whereby

[0010] ω is the spatial angle,

[0011] $(\varphi_{1R} - \varphi_{2R})$ is the scattered light flow of the test sample in the defined spatial angle (minus the scattered light proportion of the measuring installation) and

[0012] φ_{1L} is the unscattered light flow of the test sample (zero diffraction order).

[0013] In the case of known electro-optical filtering devices, the optical quality is strongly impaired by scattered light. The light scatter on an LC-cell has various causes: ~~[amongst]~~

among others, particles enclosed in the LC-cell, differing layer thicknesses, scratches, edges and/or spacers between the glass plates enclosing the liquid crystal.

[0014] US-3,961,840 shows a device for triggering of display elements for watches and portable computers. These display elements are not optical filtering elements in the sense of the invention disclosed here.

[0015] US-4,279,474 shows sunglasses with LCD-elements. The LCD-elements are for shading the glasses.

SUMMARY OF THE INVENTION

[0016] It is ~~[the task]~~ an object of the invention to create an active electro-optical filtering device and to indicate a process for its operation, in the case of which an as low as possible operating voltage is required and nonetheless a good optical quality, in particular an as small as possible impairment of it due to light scattering, is achieved.

[0017] ~~[The task is solved by the filtering device and by the process as defined in the independent claims.For the reduction of]~~ For reducing the power demand of the liquid crystal cell, the electro-optical filtering device in accordance with the invention is in preference equipped with a special driving circuit. The driving circuit in accordance with the invention contains a switch, which in every half-period short-circuits the liquid crystal cell for a certain time period. Therefore, neither a continuous trigger circuit nor a continually changing drive voltage is chosen. The drive in accordance with the invention differs from the state of the art by the insertion of an active flank and a drive process, which instead of to a continuous frequency, corresponds rather more to a pulse width modulation. The framework frequency of the driving pulses lies in the range of 0.01 to 1 Hz. The energy requirement with this process is halved in comparison with the state of the art, which represents an enormous progress.

[0018] The invention presented here utilizes an operating voltage which is unequivocally defined. On the one hand, it is several times above the Fréedericksz-threshold, in order to achieve the optical density prescribed in the product standard EN 169. In addition, the operating voltage is defined in such a manner, that it lies at the voltage, at which the light scattered by the LCD display is minimal.

[0019] The definition of the operating voltage in accordance with the invention consists in the finding that a minimum of scattered light is achieved, when in the scattered light equation (2) the numerator (essentially φ_{1R}) is smaller or else the same value as the denominator (φ_{1L}). In other words this signifies: if the scattered light proportion φ_{1R} in the operating point of the liquid crystal display is adjusted to be smaller than or equal to the residual transmission $T = 10^{(3/7)(1-N)}$, then the operating voltage has been selected as optimized with respect to scattered light. Operating frequencies defined in such a manner according to experience lie in the range of 10 to 50 Volt. The adjusting of the residual transmission can, for example, be solved with a small offset of the polarizer orientation or with an adaptation of the polarization efficiency. The scattered light influence of the measuring installation (φ_{2R}) has been neglected in the above discussion.

[0020] ~~[In the following, the invention is described in detail on the basis of Figures. These illustrate:]~~

BRIEF DESCRIPTION OF THE DRAWINGS

[0021] ~~[Fig. 1]~~These and further features of the invention will be apparent with reference to the following description and drawings, wherein:

[0022] Fig. 1 is a filtering device in accordance with the invention executed as a dazzle protection device,

[0023] Fig. 2 is an equivalent circuit diagram of a control circuit in accordance with the invention,

[0024] Fig. 3 is the operating voltage in function of time for a preferred embodiment of the operating process and

[0025] Fig. 4 shows the reduced radiant luminance in function of the operating voltage.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0026] In Figure 1, a filtering device in accordance with the invention designed as a dazzle

protection device is illustrated. It contains at least one active optical filter element 1 with a liquid crystal. The liquid crystal is implemented in accordance with one of the following technologies: TN-technology, STN-technology, dichroic technology, ferro-electric technology or π-Mode-LCD-technology. Apart from this, the filtering device contains electronic means 2 for driving the active filter element 1. At least one light sensor 4 acts in conjunction with the electronic means 2. Brought to the electronic means 2 are, for example, output signals of the light sensors 4 for the purpose of controlling, resp., closed-circuit controlling the operating voltage of the filter element. For the electronic means 2, the optical filter element 1 and possibly the light sensors 4, electric power supply means 5 are foreseen. These can be implemented, ~~[e.g]~~ <u>for example</u>., as solar cells.

[0027] It is advantageous to equip the electronic means 2 with a driving circuit, as is schematically illustrated in Figure 2. With this, the power demand of the liquid crystal cell 1 can be significantly reduced. The liquid crystal on the equivalent circuit diagram of Fig. 2 is represented by a resistor R_{LC} and a capacitor C_{LC}. Other resistors in the circuit are combined in the resistors R_{S1} and R_{S2}. An alternating current source 21 ~~[]~~supplies an alternating current $U_{\approx}$ with a framework frequency f of typically 0.01 to 1 Hz. The drive circuit in accordance with the invention contains a switch S_1, which short-circuits the liquid crystal cell for a certain time period t_s. This effects the complete discharge of the capacitor C_{LC}. The energy required for the anti-polar charging of the capacitor C_{LC} with this drive circuit is therefore halved in comparison with the state of the art.

[0028] Figure 3 shows the operating voltage U(t) supplied by the drive circuit in accordance with Fig. 2 in function of the time t. In a time period T with a typical duration of 1 to 100 sec, initially during a first time interval t_+ a, for example, positive voltage $+|U_{LC}|$ is applied to the liquid crystal cell 1. Thereafter, e.g., by closing the switch S_1 (refer to Fig. 2), during a second time interval t_{S1} the liquid crystal cell 1 is short-circuited. During a third time interval t_-thereupon a, for example, negative voltage $-|U_{LC}|$ is applied to the liquid crystal cell 1, whereupon during a fourth time interval t_{S2} once again a short-circuit takes place. In this manner, therefore active flanks 31, 32 are inserted into the course of the operating voltage U(t). This drive process in accordance with the invention corresponds most likely to a pulse width modulation. The framework frequency f = 1/T of the driving pulses lies in the range of

0.01 to 1 Hz. It has to be observed~~[,]~~ that the time intervals in Fig. 3 for reasons of clarity are not depicted to scale: While the first time interval t_+ and the third time interval t_- have typical lengths of 0.5 to 50 sec, typically the lengths of the second time interval t_{S1} and of the fourth time interval t_{S2} lie in the range of microseconds to milliseconds. The short-circuit times t_{S1}, t_{S2} are therefore shorter than the drive times t_+, t_- by factors ~~[in]~~ having an order of magnitude of 10^3 to 10^7.

[0029] Figure 4 illustrates a typical dependence of the reduced radiant luminance coefficient $l^*(U)$ (refer to equation (2)) in function of the operating voltage U. The analysis of the scatter phenomenons on a liquid crystal cell 1 is important for the comprehension of the invention. Causes of the light scattering are, for example, particles enclosed in the liquid crystal cell 1, differing layer thicknesses, scratches, edges and/or spacers between the two glass plates enclosing the liquid crystal. In the case of scattered light, one can differentiate between a static proportion l^*_S and a dynamic proportion l^*_d. The static scattered light proportion l^*_S can by means of suitable technical measures be reduced to such an extent~~[,]~~ that the user of an active dazzle-protection filter does not have to be subject to an impairment of the image quality (scattered light class 1, in accordance with European standard EN 379). Completely different is the situation in the case of the dynamic, voltage-dependent scattered light proportion l^*_d. Around the scattered light ~~[centres]~~ centers mentioned above, when an operating voltage U is applied, a local orientation disruption is produced. The foreign substance - or the edge - causing the scattered light ~~[centre]~~ center disrupts the homogeneous, chiral orientation of the liquid crystal molecules. These local orientation disruptions are to a great extent responsible for the voltage-dependent scattered light proportion l^*_d. With a higher operating voltage U, the liquid crystal molecules are aligned more and more parallel to the field strength vector and therefore the local orientation disruption is made to disappear.

[0030] The reduced radiant luminance coefficient l^* illustrated in Fig. 4, in accordance with the equation (2) is essentially the ratio of the scattered light flow φ_{1R} and the unscattered light flow φ_{1L}. In the case of the curve $l^*(U)$, three ranges can be differentiated between.

[0031] I. For low operating voltages U, φ_{1R} is < φ_{1L}, therefore l^* is < 1. In this first range I, φ_{1L} is reduced more strongly with increasing U than φ_{1R}, for which reason $l^*(U)$ increases monotonously.

[0032] II. For medium operating voltages U, φ_{1R} is $\approx \varphi_{1L}$, therefore l* is ≈ 1. In this second range II, *l**(U) is approximately constant.

[0033] III. For high operating voltage U, once again $\varphi_{1R} < \varphi_{1L}$ is applicable, therefore *l** < 1. In this third range III, φ_{1L} is reduced only a little with increasing U or is approximately constant, while on the contrary φ_{1R} for the reasons mentioned above still reduces, for which reason *l**(U) is monotonously reduced.

[0034] In accordance with the invention, the operating voltage $U = U_{LC}$ is selected in such a manner~~[,]~~ that the following conditions are fulfilled:

[0035] a) The required transmission is achieved;

[0036] b) The reduced radiant luminance coefficient *l** is minimal.

[0037] The operating voltage U_{LC} is determined from this as follows. The condition a) defines a band on the U-axis~~[,]~~ in which the operating voltage U_{LC} has to be~~[,]~~ in order to achieve the required transmission. In this band thereupon, in accordance with condition b), the operating voltage U_{LC} is unequivocally determined, so that *l** becomes minimal. Normally the operating point U_{LC} is situated in the third range III of the curve *l**(U).

[0038] If so required, the transmission can be adjusted by a slight rotation relative to one another of the polarizers or by an adaptation of the polarizer efficiency.

[0039] The present invention has been described herein with particularity, but it is noted that the scope of the invention is not limited thereto. Rather, the present invention is considered to be possible of numerous modifications, alterations, and combinations of parts and, therefore, is only defined by the claims appended hereto.

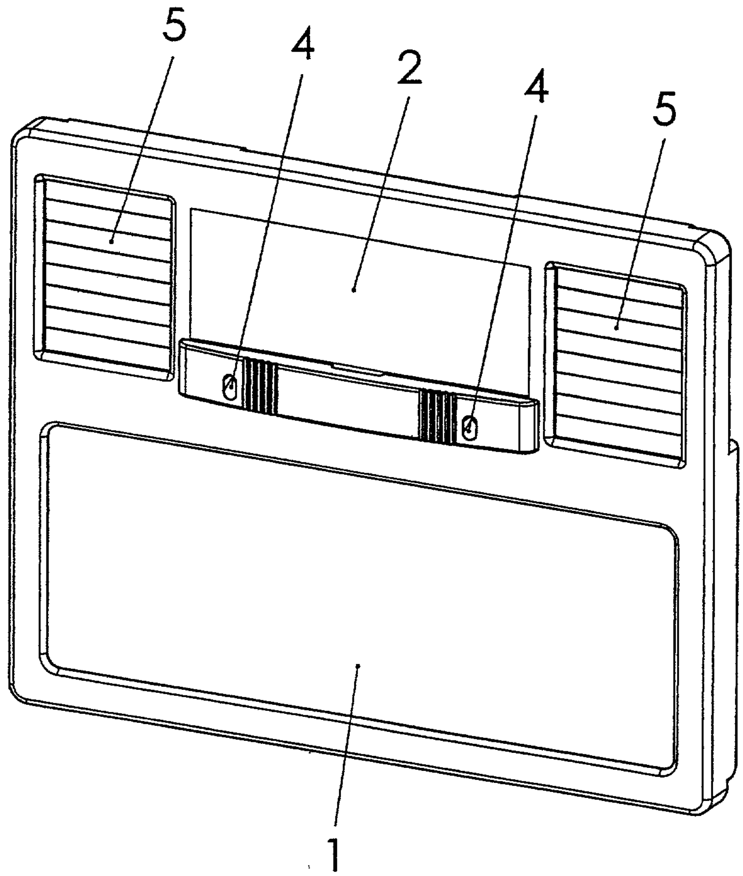

Fig. 1

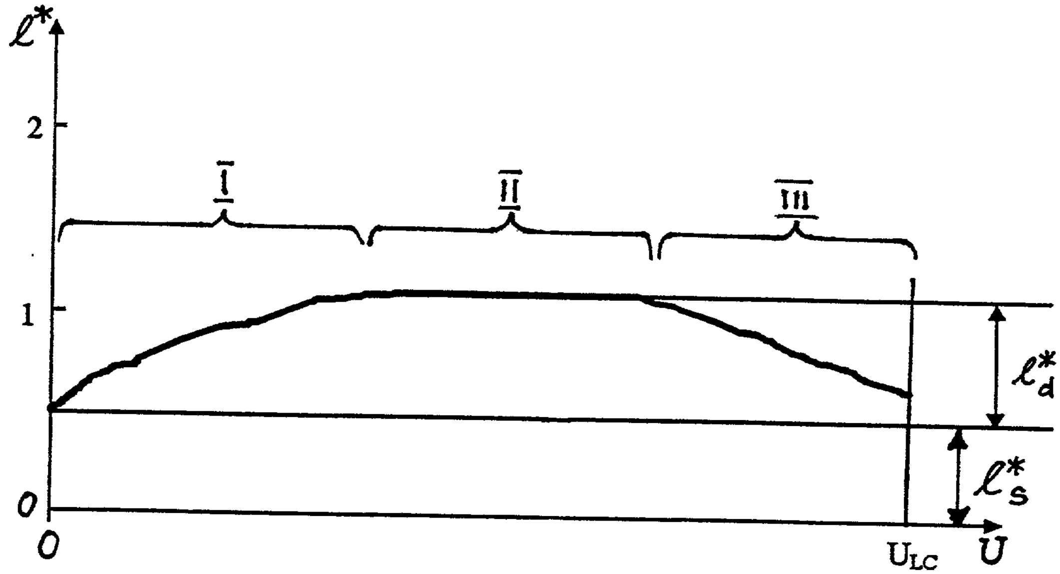

Fig. 4

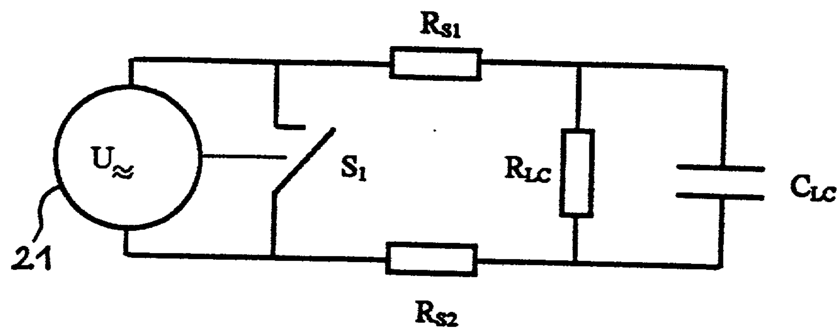

Fig. 2

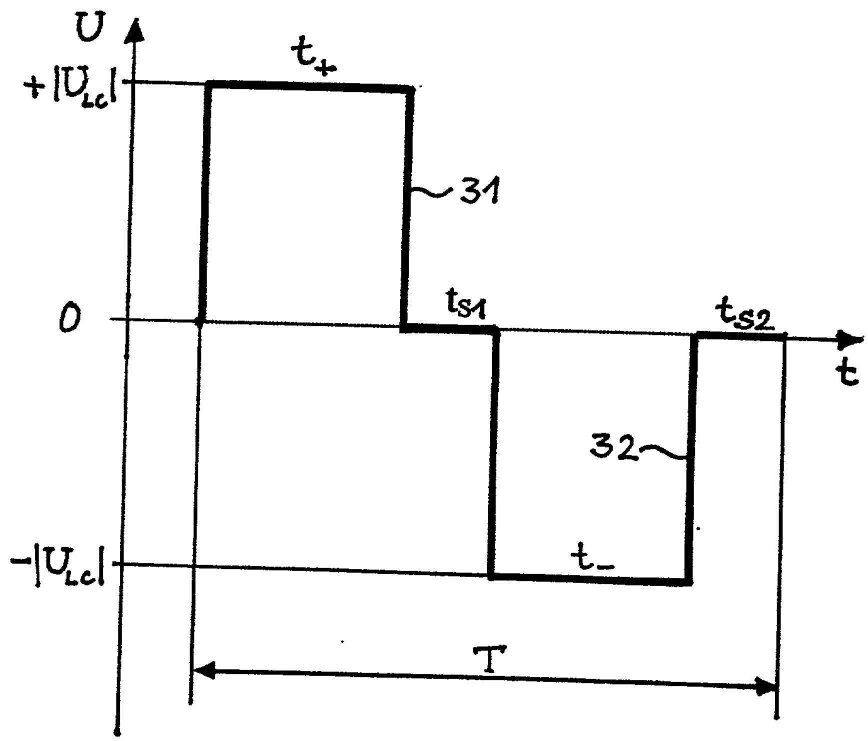

Fig. 3

P1415 US

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DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

As the below named inventor(s), I/we declare that:

This declaration is directed to:

☐ The attached application, or

☒ Application No. PCT/CH00/00040, filed on January 28, 2000,

☒ as amended on April 23, 2001 (if applicable);

I/we believe that I/we am/are the original and first inventor(s) of the subject matter which is claimed and for which a patent is sought;

I/ we have reviewed and understand the contents of the above-identified application, including the claims, as amended by any amendment specifically referred to above;

I/we acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me/us to be material to patentability as defined in 37 CFR 1.56, including material information which became available between the filing date of the prior application and the National or PCT International filing date of the continuation-in-part application, if applicable; and

All statements made herein of my/own knowledge are true, all statements made herein on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001, and may jeopardize the validity of the application or any patent issuing thereon.

FULL NAME OF INVENTOR(S)

Inventor one:	Leo Keller	Date:	x 3/9/01
Signature:	x [signature]	Citizen of:	CH
Inventor two:	Emil Ackermann	Date:	x 3/9/01
Signature:	x [signature]	Citizen of:	CH
Inventor three:		Date:	
Signature:		Citizen of:	
Inventor four:		Date:	
Signature:		Citizen of:	

☐ Additional inventors are being named on ______ additional form(s) attached hereto.